Ni/YSZ electrodes structures optimized for increased electrolysis performance and durability - DTU Orbit (09/11/2017)

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Cermet Ni/YSZ electrodes are the most commonly applied fuel electrode for solid oxide cells (SOC) both when targeting solid oxide fuel cell (SOFC) applications and when used as solid oxide electrolysis cell (SOEC). In this work we report on the correlation between initial Ni/YSZ microstructure and the resulting electrochemical performance both initially and during long-term electrolysis testing at high current density and high $p(H_2O)$ inlet. Especially, this work focuses on microstructure optimization to hinder Ni mobility and migration during long-term operation and illustrates the key-role of electrode over-potential on the degradation of the Ni/YSZ electrodes in SOEC. We find that for long-term stability for electrolysis at high current densities and high $p(H_2O)$ the as-produced NiO/YSZ precursor electrode should be: 1) As dense as possible, 2) as fine particle and pore sized as possible and 3) the three phases (Ni, YSZ and pore phase) shall be size-matched and well-dispersed. Applying such microstructure optimized Ni/YSZ electrode we show SOEC test results with long-term degradation rate as low as 0.3-0.4%/kh at - 1 A/cm^2, 800 °C and inlet gas mixture of $p(H_2O)/p(H_2)$:90/10. This enables SOEC operation of such cell for more than 5 years below thermo-neutral potential at these operating conditions.

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